Louisville Section and PES Chapter Technical Meeting

Date: Wednesday, Feb 24, 2021

Time: Presentation at 7:00 PM

Location: IEEE WebEx Virtual Meeting
RSVP to Andy Dozier for Logon Details

Price: FREE!!

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Topic: Advanced Control Systems for Grid Connected Inverters

Speaker: Dr. Michael L. McIntyre, P.E. Associate Professor, Electrical and Computer Engineering Department, J.B. Speed School of Engineering

Abstract:

Power Electronics are an enabling technology for a wide range of commercial and industrial applications. Grid connected inverters are a central component of renewable energy sources (PV-solar, wind), battery storage systems, as well as micro-grids. To optimally integrate these renewable resources, it is necessary to rethink the electric power grid itself by adjusting the centralized generation model and progressively transitioning to a distributed generation (DG) based power grid architecture through power electronic inverters and their control.

Our research focuses on developing novel control and observation strategies to improve the steady state error and dynamic performance of grid connected inverter systems. At the lowest level, existing control strategies utilize a cascaded approach, based on linear system solutions (PI-control). At a higher level, Droop control, a widely adopted method to integrate variable renewable sources, is a decentralized and communication-less control

scheme, contributing to the overall frequency (and voltage) control by emulating virtual inertia (and a virtual impedance). However, the expansion of renewable energy inevitably drops the mechanical inertia of the whole power system because these generation resources cannot store kinetic energy as they do not have a rotating mass. Hence, a mismatch between generation and consumption cannot always be mechanically compensated for, which can cause large frequency swings in the grid. Herein lies an additional problem for control system researchers to solve as the grid transitions to more inverter based resources.

This talk will briefly review existing control schemes for grid connected inverters and will highlight alternate approaches at various control system levels. Our research utilizes nonlinear control schemes to meet the over-all control objective in the presence of various forms of uncertainties and un-modeled effects present in grid connected systems. Details will be shared about our various validation environments such as simulation, HIL, and a residential scale micro-grid under development at the UofL-Conn Center.

This presentation will review an approach for developing detailed models of utility-scale solar PV and BESS that are validated using data retrieved from an operational 10 MW PV farm and 1 MW/2 MWh BESS. Additionally, a novel approach for estimating the equivalent circuit parameters for utility-scale BESS using equipment typically available at the installation site will be presented. Finally, the detailed technical benefits of a proposed configuration for integrating BESS into existing PV power plants will also be reviewed.

Speaker Biography:

Michael L. McIntyre, Ph.D., P.E. is a native of Nelson County KY. He received his B.S. and M.Eng. degrees in 1997 and 2000, respectively, from the Electrical and Computer Engineering (ECE) Department at the University of Louisville. He received a Ph. D. from the Department of Electrical Engineering, Clemson University in 2006. He was with General Electric as a senior electronic design engineer from 1998 to 2003 and then again from 2006 to 2007. He was the Kerr-Greulich Chair of Energy Systems at Western Kentucky University, Department of Engineering from 2007 to 2011. In August of 2011, he joined the ECE Department at the University of Louisville, and is currently an Associate Professor. His teaching and research Interests focused on electrical energy systems (power electronics, and electric drive systems), and control systems (linear systems, uncertain systems, and nonlinear systems). His research focuses on developing novel control and observation schemes for applications for electrical energy Systems, electrical machinery, power electronic interfaces, renewable sources, and smart grid applications. Dr. McIntyre is a senior member of IEEE, as well as a member of numerous societies within IEEE. He is an annual reviewer of various power electronic and control systems conferences and journals.